

Federal Aviation Administration – [Regulations and Policies](#)  
Aviation Rulemaking Advisory Committee

Transport Airplane and Engine Issue Area  
Braking Systems Harmonization Working Group

**Task 2 – Harmonize 25.731**

## **Task Assignment**

[Federal Register: November 26, 1999 (Volume 64, Number 227)]  
[Notices]  
[Page 66522-66524]  
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DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

Aviation Rulemaking Advisory Committee; Transport Airplane and  
Engine Issues--New and Revised Tasks

AGENCY: Federal Aviation Administration (**FAA**), DOT.

ACTION: Notice of new and revised task assignments for the Aviation  
Rulemaking Advisory Committee (ARAC).

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SUMMARY: Notice is given of new tasks assigned to and accepted by the  
Aviation Rulemaking Advisory Committee (ARAC) and of revisions to a  
number of existing tasks. This notice informs the public of the  
activities of ARAC.

FOR FURTHER INFORMATION CONTACT: Dorenda Baker, Transport Airplane  
Directorate, Aircraft Certification Service (ANM-110), 1601 Lind  
Avenue, SW., Renton, WA 98055; phone (425) 227-2109; fax (425) 227-  
1320.

SUPPLEMENTARY INFORMATION:

Background

The **FAA** has established an Aviation Rulemaking Advisory Committee  
to provide advice and recommendations to the **FAA** Administrator, through  
the Associate Administrator for Regulation and Certification, on the  
full range of the **FAA**'s rulemaking activities with respect to aviation-  
related issues. This includes obtaining advice and recommendations on  
the **FAA**'s commitment to harmonize its Federal Aviation Regulations  
(FAR) and practices with its trading partners in Europe and Canada.

One area ARAC deals with is transport airplane and engine issues.  
These issues involve the airworthiness standards for transport category

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airplanes and engines in 14 CFR parts 25, 33, and 35 and parallel  
provisions in 14 CFR parts 121 and 135. The corresponding Canadian  
standards are contained in Parts V, VI, and VII of the Canadian  
Aviation Regulations. The corresponding European standards are  
contained in Joint Aviation Requirements (JAR) 25, JAR-E, JAR-P, JAR-  
OPS-Part 1, and JAR-26.

As proposed by the U.S. and European aviation industry, and as

agreed between the Federal Aviation Administration (**FAA**) and the European Joint Aviation Authorities (JAA), an accelerated process to reach harmonization has been adopted. This process is based on two procedures:

(1) Accepting the more stringent of the regulations in Title 14 of the Code of Federal Regulations (FAR), Part 25, and the Joint Airworthiness Requirements (JAR); and

(2) Assigning approximately 41 already-tasked significant regulatory differences (SRD), and certain additional part 25 regulatory differences, to one of three categories:

<bullet> Category 1--Envelope

<bullet> Category 2--Completed or near complete

<bullet> Category 3--Harmonize

#### The Revised Tasks

ARAC will review the rules identified in the ``FAR/JAR 25 Differences List,'' dated June 30, 1999, and identify changes to the regulations necessary to harmonize part 25 and JAR 25. ARAC will submit a technical report on each rule. Each report will include the cost information that has been requested by the **FAA**. The tasks currently underway in ARAC to harmonize the listed rules are superseded by this tasking.

#### New Tasks

The **FAA** has submitted a number of new tasks for the Aviation Rulemaking Advisory Committee (ARAC), Transport Airplane and Engine Issues. As agreed by ARAC, these tasks will be accomplished by existing harmonization working groups. The tasks are regulatory differences identified in the above-referenced differences list as Rule type = P-SRD.

#### New Working Group

In addition to the above new tasks, a newly established Cabin Safety Harmonization Working Group will review several FAR/JAR paragraphs as follows:

ARAC will review the following rules and identify changes to the regulations necessary to harmonize part 25 and JAR:

- (1) Section 25.787;
- (2) Section 25.791(a) to (d);
- (3) Section 25.810;
- (4) Section 25.811;
- (5) Section 25.819; and
- (6) Section 25.813(c).

ARAC will submit a technical report on each rule. Each report will include the cost information that has been requested by the **FAA**.

The Cabin Safety Harmonization Working Group would be expected to complete its work for the first five items (identified as Category 1 or 2) before completing item 6 (identified as Category 3).

#### Schedule

Within 120 days of tasking/retasking:

<bullet> For Category 1 tasks, ARAC submits the Working Groups' technical reports to the **FAA** to initiate drafting of proposed rulemaking documents.

<bullet> For Category 2 tasks, ARAC submits technical reports, including already developed draft rules and/or advisory materials, to the **FAA** to complete legal review, economic analysis, coordination, and issuance.

June 2000: For Category 3 tasks, ARAC submits technical reports including draft rules and/or advisory materials to the **FAA** to complete legal review, economic analysis, coordination, and issuance.

#### ARAC Acceptance of Tasks

ARAC has accepted the new tasks and has chosen to assign all but one of them to existing harmonization working groups. A new Cabin Safety Harmonization Working Group will be formed to complete the remaining tasks. The working groups serve as staff to ARAC to assist ARAC in the analysis of the assigned tasks. Working group recommendations must be reviewed and approved by ARAC. If ARAC accepts a working group's recommendations, it forwards them to the **FAA** and ARAC recommendations.

#### Working Group Activity

All working groups are expected to comply with the procedures adopted by ARAC. As part of the procedures, the working groups are expected to accomplish the following:

1. Document their decisions and discuss areas of disagreement, including options, in a report. A report can be used both for the enveloping and for the harmonization processes.
2. If requested by the **FAA**, provide support for disposition of the comments received in response to the NPRM or review the **FAA**'s prepared disposition of comments. If support is requested, the Working Group will review comments/disposition and prepare a report documenting their recommendations, agreement, or disagreement. This report will be submitted by ARAC back to the **FAA**.
3. Provide a status report at each meeting of ARAC held to consider Transport Airplane and Engine Issues.

#### Participation in the Working Groups

Membership on existing working groups will remain the same, with the formation of subtask groups, if appropriate. The Cabin Safety Harmonization Working Group will be composed of technical experts having an interest in the assigned task. A working group member need not be a representative of a member of the full committee.

An individual who has expertise in the subject matter and wishes to become a member of the Cabin Safety Harmonization Working Group should write to the person listed under the caption FOR FURTHER INFORMATION CONTACT expressing that desire, describing his or her interest in the tasks, and stating the expertise he or she would bring to the working group. All requests to participate must be received no later than December 30, 1999. The requests will be reviewed by the assistant chair, the assistant executive director, and the working group chair, and the individuals will be advised whether or not the request can be accommodated.

Individuals chosen for membership on the Cabin Safety Harmonization Working Group will be expected to represent their aviation community segment and participate actively in the working group (e.g., attend all meetings, provide written comments when requested to do so, etc.). They also will be expected to devote the resources necessary to ensure the ability of the working group to meet any assigned deadline(s). Members are expected to keep their management chain advised of working group activities and decisions to ensure that the agreed technical solutions do not conflict with their sponsoring organization's position when the subject being negotiated is presented to ARAC for a vote.

Once the working group has begun deliberations, members will not be added or substituted without the approval of the assistant chair, the assistant executive director, and the working group chair.

The Secretary of Transportation has determined that the formation and use of ARAC are necessary and in the public interest in connection with the performance of duties imposed on the **FAA** by law.

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Meetings of ARAC will be open to the public. Meetings of the working groups will not be open to the public, except to the extent that individuals with an interest and expertise are selected to participate. No public announcement of working group meetings will be made.

Issued in Washington, DC, on November 19, 1999.  
Anthony F. Fazio,  
Executive Director, Aviation Rulemaking Advisory Committee.  
[FR Doc. 99-30774 Filed 11-24-99; 8:45 am]  
BILLING CODE 4910-13-M

## **Recommendation Letter**



*clw*

May 1, 1998

Department of Transportation  
Federal Aviation Administration  
800 Independence Avenue  
Washington, DC 20591

*Action: AICM*

Attn: Mr. Guy S. Gardner, Associate Administrator for Regulation and Certification

Subject: ARAC Rulemaking Package

Dear Guy:

The ARAC Transport Airplane and Engine Issues Group (TAEIG) is pleased to forward the attached rulemaking package and associated advisory material to the FAA for further action. This package has been approved by the TAEIG and contains proposals for the revision of FAR sections 25.731 and 25.735 (Standards for Brake Certification) and sections 25.613 (Material Strength Properties and Design Values), proposed Advisory Circulars and a proposed Technical Standard Order (TSO-C 135).

TAEIG requests that the FAA consider tasking the disposition any substantive comments relating to sections 25.731 and 25.735 to the Brake System Harmonization Working Group and comments relating to section 25.613 to the General Structures Harmonization Working Group. Please feel free to contact us if we can be of assistance in any way.

Sincerely,

*Craig R. Bolt*

Craig R. Bolt  
Assistant Chair, ARAC TAEIG  
boltcr@pweh.com  
(Ph: 860-565-9348/Fax: 860-565-5794)

CRB/amr

Attachment (to addressee only)

cc: Bob Amberg  
Bob Benjamin  
Jean Casciano  
Brenda Courtney  
Herb Lancaster  
Stu Miller

## **Recommendation**

[4910-13]

11/24/97

**DEPARTMENT OF TRANSPORTATION**

**Federal Aviation Administration**

**[14 CFR Part 25]**

**[Docket No.     ; Notice No.     ]**

**RIN 2120-**

**Revised Requirement for Material Strength Properties and Design Values for  
Transport Airplanes**

**AGENCY:** Federal Aviation Administration, DOT.

**ACTION:** Notice of proposed rulemaking.

**SUMMARY:** The Federal Aviation Administration proposes to revise the material strength properties and material design values requirement of the Federal Aviation Regulations (FAR) for transport category airplanes by incorporating changes developed in cooperation with the Joint Aviation Authorities (JAA) of Europe and the U.S. and European aviation industry through the Aviation Rulemaking Advisory Committee (ARAC). This action is necessary because differences between the current U.S. and European requirements impose unnecessary costs on airplane manufacturers. These proposals are intended to achieve common requirements and language between the requirements of the U.S. regulations and the Joint Aviation Requirements (JAR) of Europe, while maintaining at least the level of safety provided by the current regulations and industry practice.

**DATES:** Comments must be received on or before [insert a date 90 days after the date of publication in the Federal Register]

**ADDRESSES:** Comments on this notice may be mailed in triplicate to: Federal Aviation Administration (FAA), Office of the Chief Counsel, Attention: Rules Docket (AGC-200), Docket No.     , 800 Independence Avenue SW., Washington, DC 20591; or delivered in triplicate to: Room 915G, 800 Independence Avenue SW., Washington,

DC 20591. Comments delivered must be marked Docket No. . Comments may also be submitted electronically to: 9-NPRM-CMTS@faa.dot.gov. Comments may be examined in Room 915G weekdays, except Federal holidays, between 8:30 a.m. and 5:00 p.m. In addition, the FAA is maintaining an information docket of comments in the Transport Airplane Directorate (ANM-100), FAA, 1601 Lind Avenue SW., Renton, WA 98055-4056. Comments in the information docket may be examined weekdays, except Federal holidays, between 7:30 a.m. and 4:00 p.m.

**FOR FURTHER INFORMATION CONTACT:** William Perrella, FAA, Airframe and Propulsion Branch, ANM-112, Transport Airplane Directorate, Aircraft Certification Service, 1601 Lind Avenue, SW., Renton, WA 98055-4056; telephone (425) 227-2116, facsimile (425) 227-1320.

**SUPPLEMENTARY INFORMATION:**

**Comments Invited**

Interested persons are invited to participate in this proposed rulemaking by submitting such written data, views, or arguments as they may desire. Comments relating to any environmental, energy, or economic impact that might result from adopting the proposals contained in this notice are invited. Substantive comments should be accompanied by cost estimates. Commenters should identify the regulatory docket or notice number and submit comments in triplicate to the Rules Docket address above. All comments received on or before the closing date for comments will be considered by the Administrator before taking action on this proposed rulemaking. The proposals contained in this notice may be changed in light of comments received. All comments received will be available in the Rules Docket, both before and after the comment period closing date, for examination by interested persons. A report summarizing each substantive public contact with FAA personnel concerning this rulemaking will be filed in the docket. Persons wishing the FAA to acknowledge receipt of their comments must submit with

those comments a self-addressed, stamped postcard on which the following statement is made: "Comments to Docket No. . ." The postcard will be date stamped and returned to the commenter.

### **Availability of NPRM**

An electronic copy of this document may be downloaded using a modem and suitable communications software from the FAA regulations section of the Fedworld electronic bulletin board service (telephone: 703-321-3339), the *Federal Register's* electronic bulletin board service (telephone: 202-512-1661), or the FAA's Aviation Rulemaking Advisory Committee Bulletin Board service (telephone : 202-267-5948).

Internet users may reach the FAA's web page at <http://www.faa.gov> or the *Federal Register's* web page at [http://www.access.gpo.gov/su\\_docs](http://www.access.gpo.gov/su_docs) for access to recently published rulemaking documents.

Any person may obtain a copy of this NPRM by submitting a request to the Federal Aviation Administration, Office of Rulemaking, ARM-1, 800 Independence Avenue SW., Washington, DC 20591; or by calling (202) 267-9677. Communications must identify the notice number of this NPRM. Persons interested in being placed on a mailing list for future rulemaking documents should request from the Office of Public Affairs, Attention: Public Inquiry Center, APA-230, 800 Independence Avenue SW., 20591, or by calling (202) 267-3484, a copy of Advisory Circular No. 11-2A, Notice of Proposed Rulemaking Distribution System, which describes the application procedure.

### **Background**

The manufacturing, marketing and certification of transport airplanes is increasingly an international endeavor. In order for U. S. manufacturers to export transport airplanes to other countries the airplane must be designed to comply, not only with the U.S. airworthiness requirements for transport airplanes (14 CFR part 25), but

also with the transport airworthiness requirements of the countries to which the airplane is to be exported.

The European countries have developed a common airworthiness code for transport airplanes that is administered by the Joint Aviation Authorities (JAA) of Europe. This code is the result of a European effort to harmonize the various airworthiness codes of the European countries and is called the Joint Aviation Requirements (JAR)-25. It was developed in a format similar to 14 CFR part 25. Many other countries have airworthiness codes that are aligned closely to part 25 or to JAR-25, or they use these codes directly for their own certification purposes.

Although JAR-25 is very similar to part 25, there are differences in methodologies and criteria that often result in the need to address the same design objective with more than one kind of analysis or test in order to satisfy both part 25 and JAR airworthiness codes. These differences result in additional costs to the transport airplane manufacturers and additional costs to the U.S. and foreign authorities that must continue to monitor compliance with different airworthiness codes.

In 1988, the FAA, in cooperation with the JAA and other organizations representing the U.S. and European aerospace industries, began a process to harmonize the airworthiness requirements of the United States and the European authorities. The objective was to achieve common requirements for the certification of transport category airplanes without a substantive change in the level of safety provided by the regulations and industry practices. In 1992, the harmonization effort was undertaken by the Aviation Rulemaking Advisory Committee (ARAC). The Aviation Regulatory Advisory Committee (ARAC) was established by the FAA on February 15, 1991, with the purpose of providing information, advice, and recommendations to be considered in rulemaking activities. By notice in the Federal Register (60 FR 4222, January 20, 1995), the FAA tasked an ARAC working group of industry and government structural specialists from

Europe, the United States, and Canada to review § 25.613 of part 25, along with corresponding paragraph 25.613 of the JAR, and supporting policy and guidance material, and to recommend to the FAA appropriate revisions for harmonization, including advisory material.

The proposal described in this notice was developed by the ARAC and submitted to the FAA as a recommendation for rulemaking.

### **Discussion**

Section 25.613 of part 25 prescribes requirements for material static strength properties and design values. Metallic material strength properties for aircraft manufactured in the U.S. have traditionally been based on those specified in Military Handbook (MIL-HDBK)-5. For metallic materials not listed in that handbook, the statistical procedures in the handbook were normally used to determine material strength properties. Prior to Amendment 25-72 to part 25 of the FAR (55 FR 29786, July 20, 1990), the "A" or "B" material strength properties listed in MIL-HDBK-5, or those listed in MIL-HDBK-17, and -23, or Army-Navy-Commerce (ANC)-18, were required to be used unless specific FAA approval was granted to use other properties. With Amendment 25-72, §§ 25.613 and 25.615 were combined into one requirement, § 25.613, and the references to MIL-HDBK-5, -17, -23, and ANC-18 were removed. As part of that amendment, the requirement to use "A" and "B" properties of the military handbook was replaced by a more general requirement specifying probabilities and confidence levels for material strength properties, with the test procedures and statistical methods unspecified. Those probability and confidence levels apply to metallic as well as non-metallic materials. In Europe, other standards have been used in showing compliance with JAR 25.613, such as Euronorm (EN), International Standard Organization (ISO), and Defense (DEF) Standard 00-932.

Because Amendment 25-72 removed the provision which permitted the Administrator to approve "other design values," such an approval requires an equivalent safety finding. This finding results in additional administrative time for both the manufacturer and the FAA. To reduce this administrative burden, the FAA proposes to revise the rule to reinstate the pre-amendment 25-72 provision. In addition, other changes of a clarifying nature are proposed.

This proposal would revise § 25.613 as follows:

The heading of § 25.613 would be revised to read, "Material Strength Properties and Material Design Values." This change would clarify that the design values are material design values.

Section 25.613 (a) would remain unchanged.

Section 25.613(b) would be revised to clarify that the design values are material design values. The "A" and "B" properties published in MIL-HDBK-5 and -17, or in equivalent handbooks, would be acceptable without further statistical analysis. The statistical methods specified in MIL-HDBK-5 and -17 would be acceptable for use in establishing material design values. Other statistical methods, amounts of data, and material property data might also be accepted by the FAA, including those specified in the European Standards previously noted.

Section 25.613(c) currently requires consideration of the effects of temperature on allowable stresses used for design. The proposed revision would require consideration of environmental conditions in general, such as temperature and moisture, on material design values used in an essential component or structure, where those effects are significant in the airplane operating envelope.

Section 25.613(d) would be removed by this proposal as fatigue is now adequately addressed in § 25.571.

The premium selection process of § 25.613(e) would be revised to clarify that the design values are material design values.

A new § 25.613(f) is proposed, which would permit the use of other design values if they are approved by the Administrator.

A draft Advisory Circular, AC 25.613-1, which describes acceptable methods of compliance with this proposed rule, is being developed concurrently with this proposal. Public comments concerning the proposed AC are invited by separate notice published elsewhere in this issue of the Federal Register.

**Regulatory Evaluation, Regulatory Flexibility Determination, Trade Impact Assessment, and Unfunded Mandates Act Determination**

Proposed changes to Federal regulations must undergo several economic analyses. First, Executive Order 12866 directs that each Federal agency shall propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs. Second, the Regulatory Flexibility Act of 1980 requires agencies to analyze the economic effect of regulatory changes on small entities. Third, the Office of Management and Budget directs agencies to assess the effects of regulatory changes on international trade. In conducting these analyses, the FAA has determined that this rule: (1) will generate benefits that justify its costs and is not a "significant regulatory action" as defined in the Executive Order; (2) is not significant as defined in DOT's Regulatory Policies and Procedures; (3) will not have a significant impact on a substantial number of small entities; and (4) will not constitute a barrier to international trade. These analyses, available in the docket, are summarized below.

**Cost/Benefit Analysis**

The FAA estimates that the proposed rule would result in cost savings to manufacturers of transport category airplanes of at least \$100,000 by reinstating a provision that permits the Administrator to approve design values published in accepted

military and industry handbooks. In addition, the FAA would realize an estimated administrative cost savings of approximately \$1,350 per certification. Based on these estimates, the FAA has determined that the proposed rule is cost-beneficial.

#### Regulatory Flexibility Determination

The Regulatory Flexibility Act of 1980 (RFA) was enacted by Congress to ensure that small entities are not unnecessarily or disproportionately burdened by government regulations. The RFA requires a Regulatory Flexibility Analysis if a proposed rule would have a significant economic impact, either detrimental or beneficial, on a substantial number of small entities. FAA Order 2100.14A, Regulatory Flexibility Criteria and Guidance, establishes threshold cost values and small entity size standards for complying with RFA review requirements in FAA rulemaking actions. The Order defines "small entities" in terms of size thresholds, "significant economic impact" in terms of annualized cost thresholds, and "substantial number" as a number which is not less than eleven and which is more than one-third of the small entities subject to the proposed or final rule. Order 2100.14A specifies a size threshold for classification as a small manufacturer as 75 or fewer employees. Since none of the manufacturers affected by this proposed rule has 75 or fewer employees, the proposed rule would not have a significant economic impact on a substantial number of small manufacturers.

#### International Trade Impact Assessment

The FAA has determined that the proposed rule would not constitute a barrier to international trade, including the export of American airplanes to foreign countries and the import of foreign airplanes into the United States. The proposed requirements in this rule would harmonize with those of the JAA and would, in fact, lessen any restraints on trade.

## Unfunded Mandates Reform Act

Title II of the Unfunded Mandates Reform Act of 1995 (the Act), enacted as Pub. L. 104-4 on March 22, 1995, requires each Federal agency, to the extent permitted by law, to prepare a written assessment of the effects of any Federal mandate in a proposed or final agency rule that may result in the expenditure by State, local, and tribal governments, in the aggregate, or by the private sector, of \$100 million or more (adjusted annually for inflation) in any one year. Section 204(a) of the Act, 2 U.S.C. 1534(a), requires the Federal agency to develop an effective process to permit timely input by elected officers (or their designees) of State, local, and tribal governments on a proposed "significant intergovernmental mandate." A "significant intergovernmental mandate" under the Act is any provision in a Federal agency regulation that will impose an enforceable duty upon State, local, and tribal governments, in the aggregate, of \$100 million (adjusted annually for inflation) in any one year. Section 203 of the Act, 2 U.S.C. 1533, which supplements section 204(a), provides that before establishing any regulatory requirements that might significantly or uniquely affect small governments, the agency shall have developed a plan that, among other things, provides for notice to potentially affected small governments, if any, and for a meaningful and timely opportunity to provide input in the development of regulatory proposals.

The proposed rule does not contain any Federal intergovernmental or private sector mandate. Therefore, the requirements of Title II of the Unfunded Mandates Reform Act of 1995 do not apply.

## Federalism Implications

The regulations proposed herein would not have substantial direct effects on the states, on the relationship between the national government and the states, or on the distribution of power and responsibilities among the various levels of government. Thus, in accordance with Executive Order 12612, it is determined that this proposal would not

have sufficient federalism implications to warrant the preparation of a Federalism Assessment.

#### **International Civil Aviation Organization (ICAO) and Joint Aviation Regulations**

In keeping with U.S. obligations under the Convention on International Civil Aviation, it is FAA policy to comply with ICAO Standards and Recommended Practices to the maximum extent practicable. The FAA has determined that this proposed rule would not conflict with any international agreement of the United States.

#### **Paperwork Reduction Act**

There are no new requirements for information collection associated with this proposed rule that would require approval from the Office of Management and Budget pursuant to the Paperwork Reduction Act of 1995 (44 U.S.C. 3507(d)).

#### **Regulations Affecting Intrastate Aviation in Alaska.**

Section 1205 of the FAA Reauthorization Act of 1996 (110 Stat. 3213) requires the Administrator, when modifying regulations in Title 14 of the CFR in a manner affecting intrastate aviation in Alaska, to consider the extent to which Alaska is not served by transportation modes other than aviation, and to establish such regulatory distinctions as he or she considers appropriate. Because this proposed rule would apply to the certification of future designs of transport category airplanes and their subsequent operation, it could, if adopted, affect intrastate aviation in Alaska. The FAA therefore specifically requests comments on whether there is justification for applying the proposed rule differently to intrastate operations in Alaska.

#### **Conclusion**

Because the changes proposed in this notice are not expected to result in any substantial economic costs, the FAA has determined that this proposal would not be significant under Executive Order 12866. Because this is an issue that has not prompted a great deal of public concern, the FAA has determined that this action is not significant

under DOT Regulatory Policies and Procedures (44 FR 11034; February 25, 1979). In addition, since there are no small entities affected by this rulemaking, the FAA certifies that the rule, if promulgated, would not have a significant economic impact, positive or negative, on a substantial number of small entities under the criteria of the Regulatory Flexibility Act, since none would be affected. A copy of the regulatory evaluation prepared for this project may be examined in the Rules Docket or obtained from the person identified under the caption "FOR FURTHER INFORMATION CONTACT."

**List of Subjects in 14 CFR part 25**

Aircraft, Aviation safety, Federal Aviation Administration, Reporting and recordkeeping requirements.

**The Proposed Amendment**

Accordingly, the Federal Aviation Administration (FAA) proposes to amend 14 CFR part 25 of the Federal Aviation Regulations (FAR) as follows:

**PART 25 - AIRWORTHINESS STANDARDS: TRANSPORT CATEGORY  
AIRPLANES**

1. The authority citation for Part 25 continues to read as follows:

Authority: 49 U.S.C. 106(g), 40113, 44701-44702, 44704.

2. Section 25.613 would be amended by revising the heading and paragraphs (b) (c) and (e), by removing paragraph (d) and marking it "reserved," and by adding a new paragraph (f) to read as follows:

**§ 25.613 Material Strength Properties and Material Design Values**

(a) \*\*\*

(b) Material design values must be chosen to minimize the probability of structural failures due to material variability. Except as provided in paragraphs (e) and (f) of this section, compliance must be shown by selecting material design values which assure material strength with the following probability:

(1) \* \* \*

(2) \* \* \*

(c) The effects of environmental conditions, such as temperature and moisture, on material design values used in an essential component or structure must be considered where these effects are significant within the airplane operating envelope.

(d) [Reserved]

(e) Greater material design values may be used if a "premium selection" of the material is made in which a specimen of each individual item is tested before use to determine that the actual strength properties of that particular item will equal or exceed those used in design.

(f) Other material design values may be used if approved by the Administrator.

Issued in Washington D.C. on

First Draft: Bill Perrella June 11, 1996

Second draft: Bill Perrella Oct 17, 1996 incorporates GSHWG revisions from mtg # 12, plus some informal ANM-7 comments.

8/12/97:ps:revised per editorial comments.

9/30/97:ps/rm/wp/hl:revised per add'l. counsel cmnts and WG chair/FAA rep. review

10/21/97:ps:minor editorial correction to amendatory language

11/24/97:ps:minor editorial revisions per final counsel review

# Advisory Circular

Subject: MATERIAL STRENGTH  
PROPERTIES AND DESIGN  
VALUES

Date: DRAFT 11/24/97  
Initiated by:

AC No: 25.613-1X  
Change:

1. **PURPOSE.** This advisory circular (AC) provides guidance for compliance with the provisions of Part 25 of the Federal Aviation Regulations (FAR) which specify the requirements for material strength properties and design values. Like all advisory circular material, this advisory circular is not, in itself, mandatory and does not constitute a regulation. It is issued to provide an acceptable means, but not the only means, of compliance with the rules. Terms used in this AC, such as "shall" and "must" are used only in the sense of ensuring applicability of this particular method of compliance when the acceptable method of compliance described herein is used. While these guidelines are not mandatory, they are derived from extensive FAA and industry experience in determining compliance with the pertinent FAR. This advisory circular does not change, create any additional, authorize changes in, or permit deviations from, regulatory requirements.
2. **RELATED FAR SECTIONS.** Section 25.613 of 14 CFR part 25.
3. **RELATED ADVISORY CIRCULARS.** Advisory Circular (AC) 25.571-1C, Damage-Tolerance and Fatigue Evaluation of Structure; and AC 20-107A, Composite Aircraft Structure.
4. **DEFINITIONS.**
  - a. **Material Strength Properties.** Material properties that define the strength related characteristics of any given material. Typical examples of material strength properties are ultimate and yield values for compression, tension, bearing, shear, etc.
  - b. **Material Design Values.** Material strength properties that have been established based on the requirements of § 25.613 (b), or by other means as defined in this AC. These values are generally statistically determined based on enough data that, when used for design, the probability of structural failure due to material variability will be minimized. Typical values for moduli are used.
  - c. **Airplane Operating Envelope.** The operating limitations defined by the applicant under subpart G of part 25.
5. **BACKGROUND.** Metallic material strength properties and design values for airplanes manufactured in the U.S. have traditionally been based on those contained in Military Handbook (MIL-HDBK)-5. For materials not listed in that handbook, the statistical procedures in the handbook were normally used by U.S. manufacturers to determine design values. European

manufacturers additionally used design values and methods specified in Defense Standard (DEF STAN) 00-932 (published by ESDU International), or other equivalent approved material data. Until Amendment 25-72 to Part 25 of the FAR, the "A" or "B" material design values listed in MIL-HDBK-5, or those listed in MIL-HDBK-17, -23, or Army-Navy-Commerce (ANC) -18, were required to be used unless specific FAA approval was granted for other approaches. Sections 25.613 and 25.615 were amended in 1992, combining them into one requirement, § 25.613, and deleting the reference to MIL-HDBK-5. As part of the revision, the requirement to use A and B allowables of the military handbook was replaced by a requirement to attain certain levels of probability and confidence for strength, with the statistical method unspecified. Those probability and confidence levels apply to metallic as well as non-metallic materials. AC 20-107A contains information regarding compliance with § 25.613 for composite materials, and the use of MIL-HDBK-17.

## 6. DISCUSSION.

a. Statistically Based Design Values. Design values required by § 25.613 must be based on sufficient testing to assure a high degree of confidence in the values. In all cases, a statistical analysis of the test data must be performed.

(1) The A and B properties published in MIL-HDBK-5 or DEF STAN 00-932 are acceptable, as are the statistical methods specified in the applicable chapters/sections of those handbooks. Other methods of developing material design values may be acceptable to the FAA.

(2) The test specimens used for material property certification testing should be made from material produced using production processes. Test specimen design, test methods, and testing should:

(a) Conform to universally accepted standards such as those of the American Society for Testing Materials (ASTM), European Aerospace Series Standards (EN), International Standard Organization (ISO), or other national standards acceptable to the FAA; or

(b) Conform to those detailed in the applicable chapters/sections of MIL-HDBK-5, MIL-HDBK-17, DEF STAN 00-932, or other accepted equivalent material data handbooks; or

(c) Be accomplished in accordance with an approved test plan which includes definition of test specimens and test methods. This provision would be used, for example, when the material design values are to be based on tests that include effects of specific geometry and design features as well as material.

(3) The FAA may approve the use of other material test data after review of test specimen design, test methods, and test procedures that were used to generate the data.

b. Consideration of Environmental Conditions. The material strength properties of a number of materials, such as non-metallic composites and adhesives, can be significantly affected



*U.S. Department of Transportation  
Federal Aviation Administration  
Office of Aviation Policy and Plans*

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**PRELIMINARY REGULATORY EVALUATION,  
INITIAL REGULATORY  
FLEXIBILITY DETERMINATION,  
TRADE IMPACT ASSESSMENT , AND  
UNFUNDED MANDATES ACT DETERMINATION**

**REVISED REQUIREMENT FOR  
MATERIAL STRENGTH PROPERTIES  
AND MATERIAL DESIGN VALUES  
FOR TRANSPORT AIRPLANES  
PART 25**

**AIRCRAFT REGULATORY ANALYSIS BRANCH, APO-320  
Marilyn DonCarlos  
September 1997**

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## **I. INTRODUCTION AND EXECUTIVE SUMMARY**

This regulatory evaluation examines the impacts of a proposed rule to revise the certification requirements for material strength properties and material design values for transport category airplanes. The proposed rule would incorporate changes developed in cooperation with the Joint Aviation Authorities (JAA) of Europe and the U.S. and European aviation industry through the Aviation Rulemaking Advisory Committee (ARAC). The proposed amendment would harmonize FAA requirements with those proposed by the European Joint Aviation Requirements (JAR).

There would be no incremental costs as a result of the proposed rule. Rather, the proposed rule would result in cost savings to manufacturers and to the FAA by reinstating a provision that permits the Administrator to approve design values published in accepted military and industry handbooks. A draft Advisory Circular (AC) accompanies this proposed rule and describes acceptable methods of compliance.

Because the affected transport category airplane manufacturers are not small entities, the proposed rule would not impose a significant impact on a substantial number of small entities. The proposed changes would harmonize with those proposed by the JAA and would not constitute a barrier to international trade. In addition, the proposed rule does not contain any Federal intergovernmental or private sector mandate.

## **II. BACKGROUND**

Section 25.613 of 14 CFR part 25 (part 25) of the Federal Aviation Regulations (FAR) prescribes requirements for material strength properties and design values. Prior to Amendment 25-72 (55 FR 29776, July 20, 1980), the rule required design values to be those found in certain military or industry handbooks.<sup>1</sup> Amendment 25-72 combined §§ 25.613 and 25.615 Design properties into one requirement and removed the references to the handbooks. Instead, the amendment specified probabilities and confidence levels for material strength properties, leaving test procedures and statistical methods

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<sup>1</sup> The handbooks are: MIL-HDBK-5, "Metallic Materials and Elements for Flight Vehicle Structure;" MIL-HDBK-17, "Plastics for Flight Vehicles;" ANC-18, "Design of Wood Aircraft Structures;" and MIL-HDBK-23, "Composite Construction for Flight Vehicles."

unspecified. Amendment 25-72 also removed the provision that permitted the Administrator to approve "other design values." The applicant whose transport category airplane's material design values meet either the standards referenced in § 25.613 prior to Amendment 25-72 or comparable European standards,<sup>2</sup> but has not shown that those values meet the probability and confidence level in current § 25.613(b), must now show an equivalent level of safety as part of the FAA's certification of the airplane. This has resulted in unnecessary administrative costs to both the manufacturer and the FAA.

### **III. DISCUSSION OF THE PROPOSED RULE**

The proposed amendment was developed by the Aviation Rulemaking Advisory Committee (ARAC) and presented to the FAA as a recommendation for rulemaking. If adopted, the proposal would harmonize material strength properties and design values with those being proposed by the Joint Aviation Authorities (JAA).

The heading of § 25.613 would be revised to read "Material Strength Properties and Material Design Values." Section 25.613(b) would also be revised to clarify that the design values are material design values. Section 25.613(b) would also reference proposed new § 25.613(f), described below.

The current rule at § 25.613(c) requires consideration of the effects of temperature on allowable stresses used for design. The proposed rule would require consideration of environmental conditions in general, including temperature and moisture, on material design values used in an essential component or structure, where those effects are significant within the airplane operating envelope. Moisture can affect material design values of composites. Although not currently required in the current rule, manufacturers take into account the effect of moisture on design values. This change codifies current practice.

Section 25.613(d) would be removed. It is addressed in § 25.571 Damage tolerance and fatigue evaluation of structure, and is not needed in this section.

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<sup>2</sup> European standards include those of Euronorm (EN), International Standards Organization (ISO), and Defence (DEF) Standard 00-932.

Section 25. 613(e) would be revised to clarify that design values are material design values.

Section 25.613(f) would reinstate the provision that permits the Administrator to approve other design values. (A draft Advisory Circular, AC 25.613-1, developed concurrently with the proposed rule, would describe acceptable methods of compliance, including those published in the handbooks referenced in the rule prior to Amendment 25-72 and other standards, such as those of ASTM, the European Standards (EN), and ISO.)

#### **IV. COSTS AND BENEFITS**

Under the current rule, there are three potential options on which to base material strength properties and design values. First, a manufacturer can conduct a material properties development program for each material, product form, and heat treatment. The FAA estimates that a program for a typical material (e.g., titanium, high-strength steels) costs between \$300,000 and \$500,000. The total cost is a function of the number of materials, product forms, and heat treatments. Second, a manufacturer can also test each part (on a sampling basis) to verify strength characteristics. Based on the cost of materials, testing, and analysis, the FAA estimates the cost is \$6,000 to \$60,000 for each part over an assumed 300-airplane production run. Again, the total cost is be a function of the numbers of parts to be tested. Third, a manufacturer can request FAA approval of an equivalent safety finding. The FAA estimates that this cost is between \$100,000 and \$150,000.

Under the proposed rule, manufacturers of transport category airplanes would no longer need to use one of the options, described above. The proposed rule would reinstate the provision permitting the Administrator to approve other material design values, such as those listed in the draft AC. Based on the estimates of the available options described above, the FAA estimates that these cost savings would be at least \$100,000 per certification (the lower estimate of the least costly option). In addition, the FAA would realize an estimated cost savings of \$1,350 in administrative costs.

Based on the analysis presented above, the FAA has determined that the proposed rule would be cost-beneficial.

## **V. REGULATORY FLEXIBILITY DETERMINATION**

The Regulatory Flexibility Act of 1980 (RFA) was enacted by Congress to ensure that small entities are not unnecessarily or disproportionately burdened by government regulations. The RFA requires a Regulatory Flexibility Analysis if a proposed rule would have a significant economic impact, either detrimental or beneficial, on a substantial number of small entities. FAA Order 2100.14A, Regulatory Flexibility Criteria and Guidance, establishes threshold cost values and small entity size standards for complying with RFA review requirements in FAA rulemaking actions. The Order defines "small entities" in terms of size thresholds, "significant economic impact" in terms of annualized cost thresholds, and "substantial number" as a number which is not less than eleven and which is more than one-third of the small entities subject to the proposed or final rule.

Order 2100.14A specifies a size threshold for classification as a small manufacturer as 75 or fewer employees. Since none of the manufacturers affected by this proposed rule has 75 or fewer employees, the proposed rule would not have a significant economic impact on a substantial number of small manufacturers.

## **VI. TRADE IMPACT ASSESSMENT**

The proposed rule would not constitute a barrier to international trade, including the export of American airplanes to foreign countries and the import of foreign airplanes into the United States. The proposed requirements in this rule would harmonize with those of the JAA and would, in fact, lessen any restraints on trade.

## **VII. UNFUNDED MANDATES REFORM ACT**

Title II of the Unfunded Mandates Reform Act of 1995 (the Act), enacted as Pub. L. 104-4 on March 22, 1995, requires each Federal agency, to the extent permitted by law, to prepare a written assessment of the effects of any Federal mandate in a proposed or final agency rule that may result in the expenditure by State, local, and tribal

governments, in the aggregate, or by the private sector, of \$100 million or more (adjusted annually for inflation) in any one year. Section 204(a) of the Act, 2 U.S.C. 1534(a), requires the Federal agency to develop an effective process to permit timely input by elected officers (or their designees) of State, local, and tribal governments on a proposed "significant intergovernmental mandate." A "significant intergovernmental mandate" under the Act is any provision in a Federal agency regulation that would impose an enforceable duty upon State, local, and tribal governments, in the aggregate, of \$100 million (adjusted annually for inflation) in any one year. Section 203 of the Act, 2 U.S.C. 1533, which supplements section 204(a), provides that before establishing any regulatory requirements that might significantly or uniquely affect small governments, the agency shall have developed a plan that, among other things, provides for notice to potentially affected small governments, if any, and for a meaningful and timely opportunity to provide input in the development of regulatory proposals.

This proposed rule does not contain any Federal intergovernmental or private sector mandate. Therefore, the requirements of Title II of the Unfunded Mandates Reform Act of 1995 do not apply.



# Proposed Technical Standard Order

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**Subject:** Transport Airplane Wheels and Wheel and Brake Assemblies

1. **PURPOSE.** This Technical Standard Order (TSO) prescribes the minimum performance standards (MPS) that transport category airplane wheels, and wheel and brake assemblies must meet to be identified with the applicable TSO marking.

2. **APPLICABILITY.**

a. This TSO is effective for new applications submitted after the effective date of this TSO.

b. Previously Approved Equipment. Wheels and wheel-brake assemblies approved prior to the effective date of this TSO may continue to be manufactured under the provisions of their original approval.

3. **REQUIREMENTS.** Wheels, and wheel and brake assemblies, that are to be so identified and that are manufactured on or after the effective date of this TSO must meet the MPS qualification and documentation requirements set forth in appendix 1 of this TSO titled "Minimum Performance Specification for Transport Airplane Wheels, Brakes, and Wheel and Brake Assemblies." Brakes and associated wheels are to be considered as an assembly for TSO authorization purposes.

4. **MARKING.**

a. In addition to the marking specified in 14 CFR 21.607(d), the following information shall be legibly and permanently marked on the major equipment components:

- (1) Size (this marking applies to wheels only)
- (2) Hydraulic fluid type (this marking applies to brakes only)
- (3) Serial Number

b. The manufacturer's address required by § 21.607(d)(1) may be omitted from the markings. All stamped, etched, or embossed markings must be located in non-critical areas.

## **5. DATA REQUIREMENTS.**

a. Application Data. In addition to the data specified in § 21.605, the manufacturer must furnish one copy each of the following to the Manager of the FAA Aircraft Certification Office (ACO) having geographical purview of the manufacturer's facilities:

(1) The applicable limitations pertaining to installation of wheels or wheel and brake assemblies on airplane(s), including the data requirements of paragraph 4.1 of appendix 1 of this TSO.

(2) The manufacturer's TSO qualification test report.

b. Data to be Furnished with Manufactured Articles.

(1) Prior to entry into service use, the manufacturer must make available the applicable maintenance instructions and data necessary for continued airworthiness to the ACO specified in paragraph (c) above.

(2) The manufacturer must provide the applicable maintenance instructions and data necessary for continued airworthiness to each organization or person receiving one or more articles manufactured under this TSO. In addition, a note with the following statement must be included:

The existence of TSO approval of the article displaying required marking does not automatically constitute the authority to install and use the article on an airplane. The conditions and tests required for TSO approval of this article are minimum performance standards. It is the responsibility of those desiring to install this article either on or within a specific type or class of airplane to determine that the airplane operating conditions are within the TSO standards. The article may be installed only if further evaluation by the user/installer documents an acceptable installation and the installation is approved by the Administrator.

Additional requirements may be imposed based on airplane specifications, wheel and brake design, and quality control specifications. In-service maintenance, modifications, and use of replacement components must be in compliance with the performance standards of this TSO, as well as any additional specific airplane requirements.

## **6. AVAILABILITY OF REFERENCED DOCUMENTS.**

a. Part 21 of Title 14 CFR may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402-9325.

b. Advisory Circular No. 20-110, "Index of Aviation Technical Standard Orders," and this TSO, which includes the "Minimum Performance Specification for Transport Airplane Wheel and Wheel and Brake Assemblies" may be obtained from the U.S. Department of Transportation, Subsequent

TSO-C135

Distribution Office, SVC-121.23, Ardmore East Business Center, 3341 Q 75th Avenue, Landover,  
MD 20785.

James C. Jones  
Manager, Aircraft Engineering Division  
Aircraft Certification Service

## APPENDIX 1: MINIMUM PERFORMANCE SPECIFICATION FOR TRANSPORT AIRPLANE WHEELS, BRAKES, AND WHEEL AND BRAKE ASSEMBLIES

### CHAPTER 1 INTRODUCTION

#### 1.1 PURPOSE AND SCOPE

This Minimum Performance Specification defines the minimum performance standards for wheels, brakes, and wheel and brake assemblies to be used on airplanes certified under 14 Code of Federal Regulations (CFR) part 25. Compliance with this specification is not considered approval for installation on any transport airplane.

#### 1.2 APPLICATION

Compliance with this minimum specification by manufacturers, installers and users is required as a means of assuring that the equipment will have the capability to satisfactorily perform its intended function(s).

Note: Certain performance capabilities may be affected by airplane operational characteristics and other external influences. Consequently, anticipated airplane braking performance should be verified by airplane testing.

#### 1.3 COMPOSITION OF EQUIPMENT

The words "equipment" or "brake assembly" or "wheel assembly," as used in this document, include all components that form part of the particular unit.

For example, a wheel assembly typically includes a hub or hubs, bearings, flanges, drive bars, heat shields, and fuse plugs. A brake assembly typically includes a backing plate, torque tube, cylinder assemblies, pressure plate, heat sink, and temperature sensor.

It should not be inferred from these examples that each wheel assembly and brake assembly will necessarily include either all or any of the above example components; the actual assembly will depend on the specific design chosen by the manufacturer.

#### 1.4 DEFINITIONS AND ABBREVIATIONS

##### 1.4.1 Wheel Rated Static Load (S)

S = Maximum Static Load (Reference § 25.731(b)).

##### 1.4.2 Wheel Rated Inflation Pressure (WRP)

WRP = Wheel Rated Inflation Pressure (wheel unloaded).

<sup>14</sup>  
1.4.3 Wheel Rated Tire Loaded Radius (R)

R = Static Radius at load "S" for the Wheel Rated Tire Size at WRP. The static radius is defined as the minimum distance from the axle centerline to the tire/ground contact interface.

<sup>13</sup>  
1.4.4 Wheel Rated Radial Limit Load (L)

L = Radial Limit Load. L is the Wheel Rated Maximum Radial Limit Load (paragraph 3.2.1).

<sup>18</sup>  
1.4.5 Wheel Rated Tire Type(s) and Size(s) (TS<sub>WR</sub>)

TS<sub>WR</sub> = Wheel Rated Tire Type(s) and Size(s) defined for use and approved by the airplane manufacturer for installation on the wheel.

<sup>29</sup>  
1.4.6 Suitable Tire for Wheel Test (TT<sub>WT</sub>)

TT<sub>WT</sub> = Wheel Rated Tire Type and Size for Wheel Test.

*wheel • TT<sub>WT</sub> must*

TT<sub>WT</sub> is the tire type and size determined as being the most appropriate to introduce loads and/or pressure that would induce the most severe stresses in the wheel and must be a tire type and size approved for installation on the wheel (TS<sub>WR</sub>). The suitable tire may be different for different tests.

<sup>16</sup>  
1.4.7 Wheel/Brake Rated Structural Torque (ST<sub>R</sub>)

ST<sub>R</sub> = Wheel/Brake Rated Structural Torque.

ST<sub>R</sub> is the maximum structural torque demonstrated (paragraph 3.3.5).

<sup>10</sup>  
1.4.8 Wheel/Brake Rated Design Landing Stop Energy (KE<sub>DL</sub>)

KE<sub>DL</sub> = Wheel/Brake Rated Design Landing Stop Energy.

KE<sub>DL</sub> is the minimum energy absorbed by the wheel/brake/tire assembly during each stop of the 100 stop Design Landing Stop Test. (paragraph 3.3.2).

<sup>21</sup>  
1.4.9 Wheel/Brake Design Landing Stop Speed (V<sub>DL</sub>)

V<sub>DL</sub> = Wheel/Brake Design Landing Stop Speed.

V<sub>DL</sub> is the initial brakes-on speed for a Design Landing Stop (paragraph 3.3.2).

<sup>11</sup>  
1.4.10 Wheel/Brake Rated Accelerate-Stop Energy (KE<sub>RT</sub>)

KE<sub>RT</sub> = Wheel/Brake Rated Accelerate-Stop Energy.

$KE_{RT}$  is the energy absorbed by the wheel/brake/tire assembly demonstrated in accordance with the Accelerate-Stop test in paragraph 3.3.3.

<sup>23</sup>  
1.4.11 Wheel/Brake Accelerate-Stop Speed ( $V_{RT}$ )

$V_{RT}$  = Wheel/Brake Accelerate-Stop Speed.

$V_{RT}$  is the initial brakes-on speed used to demonstrate  $KE_{RT}$  (paragraph 3.3.3).

✓  
1.4.12 Wheel/Brake Rated Most Severe Landing Stop Energy ( $KE_{SS}$ )

$KE_{SS}$  = Wheel/Brake Rated Most Severe Landing Stop Energy.

$KE_{SS}$  is the energy absorbed by the wheel/brake/tire assembly demonstrated in accordance with paragraph 3.3.4.

<sup>24</sup>  
1.4.13 Wheel/Brake Most Severe Landing Stop Speed ( $V_{SS}$ )

$V_{SS}$  = Wheel/Brake Most Severe Landing Stop Speed.

$V_{SS}$  is the initial brakes-on speed used to demonstrate  $KE_{SS}$  (paragraph 3.3.4).

<sup>5</sup>  
1.4.14 Brake Rated Wear Limit (BRWL)

BRWL = Brake maximum wear limit to ensure compliance with paragraph 3.3.3, and, if applicable, paragraph 3.3.4.

<sup>22</sup>  
1.4.15 Airplane Maximum Rotation Speed ( $V_R$ )

$V_R$  = Airplane Maximum Rotation Speed.

1.4.16 Brake Rated Maximum Operating Pressure ( $BROP_{MAX}$ )

$BROP_{MAX}$  = Brake Rated Maximum Operating Pressure.

$BROP_{MAX}$  is the maximum design metered pressure which is available to the brake to meet airplane stopping performance requirements.

<sup>2</sup>  
1.4.17 Brake Rated Maximum Pressure ( $BRP_{MAX}$ )

$BRP_{MAX}$  = Brake Rated Maximum Pressure

$BRP_{MAX}$  is the maximum pressure to which the brake is designed to be subjected (typically airplane nominal maximum system pressure).

1.4.18<sup>4</sup> Brake Rated Maximum Parking Pressure (BRPP<sub>MAX</sub>).

BRPP<sub>MAX</sub> = Brake Rated Maximum Parking Pressure.

BRPP<sub>MAX</sub> is the maximum parking pressure available to the brake.

1.4.19<sup>3</sup> Brake Rated Retraction Pressure (BRP<sub>RET</sub>)

BRP<sub>RET</sub> = Brake Rated Retraction Pressure.

BRP<sub>RET</sub> is the highest pressure at which piston retraction to the unpressurized position is assured.

1.4.20<sup>6</sup> Distance Averaged Deceleration (D)

$$D = ((\text{Initial brakes-on speed})^2 - (\text{Final brakes-on speed})^2) / (2 (\text{braked flywheel distance}))$$

D is the distance averaged deceleration to be used in all deceleration calculations.

1.4.21<sup>7</sup> Rated Design Landing Deceleration (D<sub>DL</sub>).

D<sub>DL</sub> = Rated Design Landing Deceleration.

D<sub>DL</sub> is the minimum of the distance averaged deceleration values demonstrated during the 100 KE<sub>DL</sub> stops of paragraph 3.3.2.

1.4.22<sup>8</sup> Rated Accelerate-Stop Deceleration (D<sub>RT</sub>).

D<sub>RT</sub> = Rated Accelerate -Stop Deceleration.

D<sub>RT</sub> is the distance averaged deceleration which the wheel/brake/tire assembly will produce when absorbing KE<sub>RT</sub>.

1.4.23<sup>9</sup> Rated Most Severe Landing Stop Deceleration (D<sub>SS</sub>).

D<sub>SS</sub> = Rated Most Severe Landing Stop Deceleration.

D<sub>SS</sub> is the distance averaged deceleration which the wheel/brake /tire assembly will produce when absorbing KE<sub>SS</sub>.

1.4.24<sup>17</sup> Brake Rated Tire Type(s) and Size(s) (TS<sub>BR</sub>).

TS<sub>BR</sub> = Brake Rated Tire Type(s) and Size(s).

TS<sub>BR</sub> is the tire type(s) and size(s) used to achieve the KE<sub>DL</sub>, KE<sub>RT</sub>, and KE<sub>SS</sub> brake ratings.

19  
1.4.23 Suitable Tire for Brake Tests (TT<sub>BT</sub>).

TT<sub>BT</sub> = Rated Tire Type and Size.

tests. TT<sub>BT</sub> must

TT<sub>BT</sub> is the tire type and size that has been determined as being the most critical for brake performance and/or energy absorption tests, and must be a tire type and size approved for installation on the wheel. The suitable tire may be different for different tests.

1.4.26 Brake Lining.

Brake lining is individual blocks of wearable material, discs that have wearable material integrally bonded to them, or discs in which the wearable material is an integral part of the disc structure.

1.4.27 Heat Sink

The heat sink is the mass of the brake that is primarily responsible for absorbing energy during a stop. For a typical brake, this would consist of the stationary and rotating disc assemblies.

## **CHAPTER 2**

### **GENERAL DESIGN SPECIFICATION**

#### **2.1 AIRWORTHINESS.**

The airworthiness of the airplane on which the equipment is to be installed must be considered. (See the paragraph titled "Data to be Furnished with Manufactured Articles.")

#### **2.2 FIRE PROTECTION.**

Except for small parts (such as fasteners, seals, grommets and small electrical parts) that would not contribute significantly to the propagation of a fire, all solid materials used must be self-extinguishing. See also paragraphs 3.3.3.5 and 3.3.4.5.

#### **2.3 DESIGN.**

Unless shown to be unnecessary by test or analysis, the equipment must comply with the following:

##### **2.3.1 Wheel Bearing Lubricant Retainers.**

Wheel bearing lubricant retainers must retain the lubricant under all operating conditions, prevent the lubricant from reaching braking surfaces, and prevent foreign matter from entering the bearings.

##### **2.3.2 Removable Flanges.**

All removable flanges must be assembled onto the wheel in a manner that will prevent the removable flanges and retaining devices from leaving the wheel if a tire deflates while the wheel is rolling.

##### **2.3.3 Adjustment.**

The brake mechanism must be equipped with suitable adjustment devices to maintain appropriate running clearance when subjected to BRP<sub>RET</sub>.

##### **2.3.4 Water Seal.**

Wheels intended for use on amphibious aircraft must be sealed to prevent entrance of water into the wheel bearings or other portions of the wheel or brake, unless the design is such that brake action and service life will not be impaired by the presence of sea water or fresh water.

### 2.3.5 Burst Prevention.

Means must be provided to prevent wheel failure and tire burst that might otherwise result from overpressurization or from elevated brake temperatures. The means must take into account the pressure and the temperature gradients over the full operating range.

### 2.3.6 Wheel Rim and Inflation Valve.

Tire and Rim Association (Reference: Aircraft Year Book-Tire and Rim Association Inc.) or, alternatively, The European Tyre and Rim Technical Organization (Reference: Aircraft Tyre and Rim Data Book) approval of the rim dimensions and inflation valve is encouraged.

### 2.3.7 Brake Piston Retention.

The brake must incorporate means to ensure that the actuation system does not allow hydraulic fluid to escape if the limits of piston travel are reached.

### 2.3.8 Wear Indicator.

A reliable method must be provided for determining when the heat sink is worn to its permissible limit.

### 2.3.9 Wheel Bearings.

Means should be incorporated to avoid misassembly of wheel bearings.

### 2.3.10 Fatigue.

The design of the wheel must incorporate techniques to improve fatigue resistance of critical areas of the wheel and minimize the effects of the expected corrosion and temperature environment. The wheel must include design provisions to minimize the probability of fatigue failures that could lead to flange separation or other wheel burst failures.

### 2.3.11 Dissimilar Metals.

Adequate protection must be provided to prevent electrolytic action when dissimilar metals are used. In addition, differential thermal expansion must not unduly affect the load capability and fatigue life.

## 2.4 CONSTRUCTION.

### 2.4.1 Castings.

Castings must be of high quality, clean, sound, and free from blowholes, porosity, or surface defects caused by inclusions, except that loose sand or entrapped gases may be allowed when serviceability is not impaired.

#### 2.4.2 Forgings.

Forgings must be of uniform condition, free from blisters, fins, folds, seams, laps, cracks, segregation, and other defects. Imperfections may be removed if strength and serviceability would not be impaired as a result..

#### 2.4.3 Bolts and Studs.

When bolts or studs are used for fastening together sections of a wheel or brake, the length of the threads must be sufficient to fully engage the nut, including its locking feature, and there must be sufficient unthreaded bearing area to carry the required load.

#### 2.4.4 Corrosion Protection.

Corrosion protection means, where used, must be compatible with the expected environment. This protection must include protection for all holes and passages exposed to potentially corrosive environments.

#### 2.4.5 Magnesium Parts.

Magnesium parts must not be used on brakes or braked wheels.

#### 2.4.6 Bearing and Braking Surface.

Surface and protective finishes must not be applied to bearings and braking surfaces..

**CHAPTER 3****MINIMUM PERFORMANCE UNDER STANDARD TEST CONDITIONS****3.1 INTRODUCTION.**

The test conditions and performance criteria described in this Chapter provide a laboratory means of demonstrating compliance with this TSO minimum performance standard. The airplane manufacturer must define all relevant test parameter values.

**3.2 WHEEL TESTS.**

To establish the ratings for a wheel, it must be substantiated that standard production wheel samples will meet the following radial load, combined load, roll load, roll-on-rim (if applicable) and overpressure test requirements.

For all tests, except the roll-on-rim test of paragraph 3.2.4, the wheel must be fitted with a suitable tire,  $TT_{WT}$ , and wheel loads must be applied through the tire. The ultimate load tests of paragraphs 3.2.1.3 and 3.2.2.3 provide for an alternative method of loading if it is not possible to conduct these tests with the tire mounted.

**3.2.1 Radial Load Test.**

If the radial limit load of paragraph 3.2.2 is equal to or greater than the radial limit load of this paragraph, the test specified in this paragraph may be omitted.

Test the wheel for yield and ultimate loads as follow:

**3.2.1.1 Test method.**

With a suitable tire,  $TT_{WT}$ , installed, mount the wheel on its axle, and position it against a flat, non-deflecting surface. The wheel axle must have the same angular orientation to the non-deflecting surface that it will have to a flat runway when it is mounted on an airplane and is under the maximum radial limit load,  $L$ . Inflate the tire to the pressure recommended for the Wheel Rated Static Load,  $S$ , with gas and/or liquid.

If liquid inflation is used, liquid must be bled off to obtain the same tire deflection that would result if gas inflation were used.

Liquid pressure must not exceed the pressure that would develop if gas inflation were used and the tire were deflected to its maximum extent. Load the wheel through its axle with the load applied perpendicular to the flat, non-deflecting surface. Deflection readings must be taken at suitable points to indicate deflection and permanent set of the wheel rim at the bead seat.

### 3.2.1.2 Yield Load.

Apply to the wheel and tire assembly a load not less than 1.15 times the maximum radial limit load, L, as determined under 14 CFR 25.471 through 25.511, as appropriate.

Determine the most critical wheel orientation with respect to the non-deflecting surface. Apply the load with the tire loaded against the non-deflecting surface, and with the wheel rotated 90 degrees with respect to the most critical orientation. Repeat the loading with the wheel 180, 270, and 0 degrees from the most critical orientation. The bearing cups, cones, and rollers used in operation must be used for these loadings.

Three successive loadings at the 0 degree position must not cause permanent set increments of increasing magnitude. The permanent set increment caused by the last loading at the 0 degree position may not exceed 5 percent of the deflection caused by that loading or .005 inches (.125mm), whichever is greater. There must be no yielding of the wheel such as would result in loose bearing cups, liquid or gas leakage through the wheel or past the wheel seal. There must be no interference in any critical areas between the wheel and brake assembly, or between the most critical deflected tire and brake (with fittings) up to limit load conditions, taking into account the axle flexibility. Lack of interference can be established by analyses and/or tests.

### 3.2.1.3 Ultimate Load.

Apply to the wheel used in the yield test of paragraph 3.2.1.2, and the tire assembly, a load not less than 2 times the maximum radial limit load, L, for castings, and 1.5 times the maximum radial limit load, L, for forgings, as determined under 14 CFR 25.471 through 25.511, as appropriate.

Apply the load with the tire and wheel against the non-deflecting surface and the wheel positioned at 0 degree orientation (paragraph 3.2.1.2). The bearing cones may be replaced with conical bushings, but the cups used in operation must be used for this loading. If, at a point of loading during the test, it is shown that the tire will not successfully maintain pressure or if bottoming of the tire occurs, the tire pressure may be increased. If bottoming of the tire continues to occur with increased pressure, a loading block that fits between the rim flanges and simulates the load transfer of the inflated tire may be used. The arc of the wheel supported by the loading block must be no greater than 60 degrees.

The wheel must support the load without failure for at least 3 seconds. Abrupt loss of load-carrying capability or fragmentation during the test constitutes failure.

### 3.2.2 Combined Radial and Side Load Test.

Test the wheel for the yield and ultimate loads as follows:

### 3.2.2.1 Test Method.

With a suitable tire,  $TT_{WT}$ , installed, mount the wheel on its axle and position it against a flat, non-deflecting surface. The wheel axle must have the same angular orientation to the non-deflecting surface that it will have to a flat runway when it is mounted on an airplane and is under the combined radial and side limit loads. Inflate the tire to the pressure recommended for the maximum static load with gas and/or liquid.

If liquid inflation is used, liquid must be bled off to obtain the same tire deflection that would result if gas inflation were used.

Liquid pressure must not exceed the pressure that would develop if gas inflation were used and the tire were deflected to its maximum extent. For the radial load component, load the wheel through its axle with load applied perpendicular to the flat non-deflecting surface. Apply the two loads simultaneously, increasing them either continuously or in increments no greater than 10 percent of the total loads to be applied.

If it is impossible to generate the side load because of friction limitations, the radial load may be increased, or a portion of the side load may be applied directly to the tire/wheel. In such circumstances it must be demonstrated that the moment resulting from the side load is no less severe than would otherwise have occurred.

Alternatively, the vector resultant of the radial and side loads may be applied to the axle. Deflection readings must be taken at suitable points to indicate deflection and permanent set of the wheel rim at the bead seat.

X  
X

### 3.2.2.2 Combined Yield Load.

Apply to the wheel and tire assembly radial and side loads not less than 1.15 times the respective ground limit loads, as determined under 14 CFR 25.485, 25.495, 25.497, and 25.499 as appropriate.

Determine the most critical wheel orientation with respect to the non-deflected surface.

Apply the load with the tire loaded against the non-deflecting surface, and with the wheel rotated 90 degrees with respect to the most critical orientation. Repeat the loading with the wheel 180, 270, and 0 degrees from the most critical orientation.

The bearing cups, cones, and rollers used in operation must be used in this test.

A tube may be used in a tubeless tire only when it has been demonstrated that pressure will be lost due to the inability of a tire bead to remain properly positioned under the load. The wheel must be tested for the most critical inboard and outboard side loads.

Three successive loadings at the 0 degree position must not cause permanent set increments of increasing magnitude. The permanent set increment caused by the last loadings at the 0 degree

position must not exceed 5 percent of the deflection caused by the loading, or .005 inches (.125mm), whichever is greater. There must be no yielding of the wheel such as would result in loose bearing cups, gas or liquid leakage through the wheel or past the wheel seal. There must be no interference in any critical areas between the wheel and brake assembly, or between the most critical deflected tire and brake (with fittings) up to limit load conditions, taking into account the axle flexibility. Lack of interference can be established by analyses and/or tests.

### 3.2.2.3 Combined Ultimate Load.

Apply to the wheel, used in the yield test of paragraph 3.2.2.2, radial and side loads not less than 2 times for castings and 1.5 times for forgings, the respective ground limit loads as determined under 14 CFR 25.485, 25.495, 25.497, and 25.499, as appropriate.

Apply these loads with a tire and wheel against the non-deflecting surface and the wheel oriented at the 0 degree position (paragraph 3.2.2.2). The bearing cones may be replaced with conical bushings; however, the cups used in operation must be used for this loading.

If, at any point of loading during the test, it is shown that the tire will not successfully maintain pressure, or if bottoming of the tire on the non-deflecting surface occurs, the tire pressure may be increased. If bottoming of the tire continues to occur with this increased pressure, a loading block that fits between the rim flanges and simulates the load transfer of the inflated tire may be used. The arc of wheel supported by the loading block must be no greater than 60 degrees.

The wheel must support the loads without failure for at least 3 seconds. Abrupt loss of load-carrying capability or fragmentation during the test constitutes failure.

## 3.2.3 Wheel Roll Test.

### 3.2.3.1 Test Method.

With a suitable tire,  $TT_{WT}$ , installed, mount the wheel on its axle and position it against a flat non-deflecting surface or a flywheel. The wheel axle must have the same angular orientation to the non-deflecting surface that it will have to a flat runway when it is mounted on an airplane and is under the Wheel Rated Static Load,  $S$ . During the roll test, the tire pressure must not be less than 1.14 times the Wheel Rated Inflation Pressure,  $WRP$ , (0.10 to account for temperature rise and 0.04 to account for loaded tire pressure). For side load conditions, the wheel axle must be-yawed to the angle that will produce a wheel side load component equal to 0.15  $S$  while the wheel is being roll tested.

### 3.2.3.2 Roll Test.

The wheel must be tested under the loads and for the distances shown in Table 3-1.

TABLE 3-1 Load Conditions and Roll Distances for Roll Test

Load Conditions	Roll Distance Miles (km)
Wheel Rated Static Load, S	2000 (3220)
Wheel Rated Static Load, S plus 0.15 S side load applied in the outboard direction	100 (161)
Wheel Rated Static Load, S plus 0.15 S side load applied in the inboard direction	100 (161)

At the end of the test, the wheel must not be cracked, there must be no leakage through the wheel or past the wheel seal(s), and the bearing cups must not be loose.

#### 3.2.4 Roll-on-Rim Test (not applicable to nose wheels).

The wheel assembly without a tire must be tested at a speed of no less than 9 knots under a load equal to the Wheel Rated Static Load, S. The test roll distance (in feet) must be determined as  $0.5VR^2$  but need not exceed 15,000 feet (4572 meters). The test axle angular orientation with the load surface must represent that of the airplane axle to the runway under the static load S.

The wheel assembly must support the load for the distance defined above. During the test, no fragmentation of the wheel is permitted; cracks are allowed.

#### 3.2.5 Overpressure Test.

The wheel assembly, with a suitable tire,  $TT_{WT}$ , installed, must be tested to demonstrate that it can withstand the application of 4.0 times the wheel rated inflation pressure, WRP. The wheel must retain the pressure for at least 3 seconds. Abrupt loss of pressure containment capability or fragmentation during the test constitutes failure. Plugs may be used in place of overpressurization protection device(s) to conduct this test.

#### 3.2.6 Diffusion Test.

A tubeless tire and wheel assembly must hold its rated inflation pressure, WRP, for 24 hours with a pressure drop no greater than 5 percent. This test must be performed after the tire growth has stabilized.

### 3.3 WHEEL AND BRAKE ASSEMBLY TESTS.

#### 3.3.1 General.

3.3.1.1 The wheel and brake assembly, with a suitable tire, TTBT, installed, must be tested on a testing machine in accordance with the following, as well as paragraphs 3.3.2, 3.3.3, 3.3.5 and, if applicable, 3.3.4.

3.3.1.2 For tests detailed in paragraphs 3.3.2, 3.3.3 and 3.3.4, the test energies  $KE_{DL}$ ,  $KE_{RT}$ , and  $KE_{SS}$  and brake application speeds  $V_{DL}$ ,  $V_{RT}$ , and  $V_{SS}$  are as defined by the airplane manufacturer.

3.3.1.3 For tests detailed in paragraphs 3.3.2, 3.3.3 and 3.3.4, the initial brake application speed must be as close as practicable to, but not greater than, the speed established in accordance with paragraph 3.3.1.2, with the exception that marginal speed increases are allowed to compensate for brake pressure release permitted under paragraphs 3.3.3.4 and 3.3.4.4. An increase in the initial brake application speed is not a permissible method of accounting for a reduced (i.e. lower than ideal) dynamometer mass. This method is not permissible because, for a target test deceleration, a reduction in the energy absorption rate would result, and could produce performance different from that which would be achieved with the correct brake application speed. The energy to be absorbed during any stop must not be less than that established in accordance with paragraph 3.3.1.2. Additionally, forced air or other artificial cooling means are not permitted during these stops.

3.3.1.4 The brake assembly must be tested using the fluid (or other actuating means) specified for use with the brake on the airplane.

### 3.3.2 Design Landing Stop Test.

3.3.2.1 The wheel and brake assembly under test must complete 100 stops at the  $KE_{DL}$  energy, each at the mean deceleration,  $D$ , defined by the airplane manufacturer, but not less than  $10 \text{ ft/s}^2$  ( $3.05 \text{ m/s}^2$ ).

3.3.2.2 During the design landing stop test, the disc support structure must not be changed if it is intended for reuse, or if the wearable material is integral to the structure of the disc. One change of individual blocks or integrally bonded wearable material is permitted. For discs using integrally bonded wearable material, one change is permitted, provided that the disc support structure is not intended for reuse. The remainder of the wheel/brake assembly parts must withstand the 100  $KE_{DL}$  stops without failure or impairment of operation.

### 3.3.3 Accelerate -Stop Test.

3.3.3.1 The wheel and brake assembly under test must complete the Accelerate-Stop test at the mean deceleration,  $D$ , defined by the airplane manufacturer, but not less than  $6 \text{ ft/s}^2$  ( $1.83 \text{ m/s}^2$ ).

This test establishes the maximum takeoff energy rating,  $KE_{RT}$ , of the wheel and brake assembly using:

- a. The Brake Rated Maximum Operating Pressure,  $BROP_{MAX}$ ; or
- b. The maximum brake pressure consistent with the airplane's braking pressure limitations (e.g., tire/runway drag capability based on substantiated data).

3.3.3.2 For the accelerate-stop test, the tire, wheel, and brake assembly must be capable of absorbing the test energy, KERT, using a brake on which the usable wear range of the heat sink BRWL has already been fully consumed.

The proportioning of wear through the brake for the various friction pairs for this test must be based on service wear experience or wear test data of an equivalent or similar brake. Either operationally worn or mechanically worn brake components may be used. If mechanically worn components are used, it must be shown that they can be expected to provide similar results to operationally worn components. The test brake must be subjected to a sufficient number and type of stops to ensure that the brake's performance is representative of in-service use; at least one of these stops, with the brake near the fully worn condition, must be a Design Landing Stop.

3.3.3.3 At the time of brake application, the temperatures of the tire, wheel, and brake, particularly the heat sink, must, as closely as practicable, be representative of a typical in-service condition. Preheating by a taxi stop(s) is an acceptable means.

These temperatures must be based on a rational analysis of a braking cycle, taking into account a typical brake temperature at which an airplane may be dispatched from the ramp, plus a conservative estimate of heat sink temperature change during subsequent taxiing, and takeoff acceleration, as appropriate.

Alternatively, in the absence of a rational analysis, the starting heat sink temperature must be that resulting from the application of 10 percent KERT to the tire, wheel and brake assembly initially at not less than normal ambient temperature (59°F/15°C).

3.3.3.4 A full stop demonstration is not required for the worn brake accelerate-stop test. The test brake pressure may be released at a test speed of up to 20 knots. In this case, the initial brakes-on speed must be adjusted such that the energy absorbed by the tire, wheel and brake assembly during the test is not less than the energy absorbed if the test had commenced at the specified speed and continued to zero ground speed.

3.3.3.5 Within 20 seconds of completion of the stop, or of the brake pressure release in accordance with paragraph 3.3.3.4, the brake pressure must be adjusted to the Brake Rated Maximum Parking Pressure  $BRPP_{MAX}$  and maintained for 3 minutes.

No sustained fire that extends above the level of the highest point of the tire is allowed before 5 minutes have elapsed after application of parking brake pressure; until this time has elapsed, neither fire fighting means nor coolants may be applied.

The time of initiation of tire pressure release (e.g., by wheel fuse plug), if applicable, is to be recorded. The sequence of events described in paragraphs 3.3.3.4 and 3.3.3.5 is illustrated in figure 3-1.

#### 3.3.4 Most Severe Landing Stop Test

3.3.4.1 The wheel and brake assembly under test must complete the most severe landing braking condition expected on the airplane as defined by the airplane manufacturer. This test is not required if the testing required by paragraph 3.3.3 is more severe or the condition is shown to be extremely improbable by the airplane manufacturer.

This test establishes, if required, the maximum energy rating,  $KE_{ss}$ , of the wheel/brake assembly for landings under abnormal conditions using:

- a. The Brake Rated Maximum Operating Pressure,  $BROP_{MAX}$ ; or
- b. The maximum brake pressure consistent with an airplane's braking pressure limitations (e.g., tire/runway drag capability based on substantiated data).

3.3.4.2 For the Most Severe Landing Stop test, the tire, wheel and brake assembly must be capable of absorbing the test energy,  $KE_{SS}$ , with a brake on which the usable wear range of the heat sink BRWL has already been fully consumed.

The proportioning of wear through the brake for the various friction pairs for this test must be based on service wear experience or wear test data of an equivalent or similar brake. Either operationally worn or mechanically worn brake components may be used. If mechanically worn components are used, it must be shown that they can be expected to provide similar results to operationally worn components. The test brake must be subjected to a sufficient number and type of stops to ensure that the brake's performance is representative of in-service use; at least one of these stops, with the brake near the fully worn condition, must be a Design Landing Stop.

3.3.4.3 At the time of brake application, the temperatures of the tire, wheel, and brake, particularly the heat sink, must, as closely as practicable, be representative of a typical in-service condition. Preheating by a taxi stop(s) is an acceptable means.

These temperatures must be based on a rational analysis of a braking cycle, taking into account a typical brake temperature at which the airplane may be dispatched from the ramp, plus a conservative estimate of heat sink temperature change during taxi, takeoff, and flight, as appropriate.

Alternatively, in the absence of a rational analysis, the starting heat sink temperature must be that resulting from the application of 5 percent  $KERT$  to the tire, wheel and brake assembly initially at not less than normal ambient temperature ( $59^{\circ}F/15^{\circ}C$ ).

3.3.4.4 A full stop demonstration is not required for the most severe landing-stop test. The test brake pressure may be released at a test speed of up to 20 knots. In this case, the initial brakes-on speed must be adjusted such that the energy absorbed by the tire, wheel, and brake assembly during the test is not less than the energy absorbed if the test had commenced at the specified speed and continued to zero ground speed.

3.3.4.5 Within 20 seconds of completion of the stop, or of the brake pressure release in accordance with paragraph 3.3.4.4, the brake pressure must be adjusted to the Brake Rated Maximum Parking Pressure,  $BRPP_{MAX}$ , and maintained for 3 minutes.

No sustained fire that extends above the level of the highest point of the tire is allowed before 5 minutes have elapsed after application of parking brake pressure; until this time has elapsed, neither fire fighting means nor coolants may be applied.

The time of initiation of tire pressure release (e.g., by wheel fuse plug), if applicable, is to be recorded. The sequence of events described in paragraphs 3.3.4.4 and 3.3.4.5 is illustrated in Figure 3-2.

### 3.3.5 Structural Torque Test

3.3.5.1 Apply to the wheel, brake and tire assembly, the radial load  $S$  and the drag load corresponding to the torque specified in paragraph 3.3.5.2 or 3.3.5.3, as applicable, for at least 3 seconds. Rotation of the wheel must be resisted by a reaction force transmitted through the brake, or brakes, by the application of at least Brake Rated Maximum Operating Pressure,  $BROP_{MAX}$ , or equivalent. If such pressure or its equivalent is insufficient to prevent rotation, the friction surface may be clamped, bolted, or otherwise restrained while applying the pressure. A fully worn brake configuration,  $BRWL$ , must be used for this test. The proportioning of wear through the brake for the various friction pairs for this test must be based on service wear experience of an equivalent or similar brake or test machine wear test data. Either operationally worn or mechanically worn brake components may be used. The wheel/brake rated structural torque ( $ST_R$ ) is equal to the torque demonstrated in the test defined in 3.3.5.1.

3.3.5.2 For landing gear with one wheel per landing gear strut, the torque is  $1.2 (SxR)$ .

3.3.5.3 For landing gear with more than one wheel per landing gear strut, the torque is  $1.44 (SxR)$ .

3.3.5.4 The wheel and brake assembly must support the loads without failure for at least 3 seconds.

## 3.4 BRAKE TESTS.

It must be substantiated that standard production samples of the brake will pass the following tests:

### 3.4.1 Yield & Overpressure Test.

The brake must withstand a pressure equal to 1.5 times  $BRP_{MAX}$  for 5 minutes without permanent deformation of the structural components under test.

The brake, with actuator piston(s) extended to simulate a maximum worn condition, must, for at least 3 seconds, withstand hydraulic pressure equal to two times the brake rated maximum pressure,  $BRP_{MAX}$ , available to the brakes. If necessary, piston extension must be adjusted to prevent contact with retention devices during this test.

### 3.4.2 Endurance Test.

A brake assembly must be subjected to an endurance test during which structural failure or malfunction must not occur. If desired, the heat sink components may be replaced by a reasonably representative dummy mass for this test.

The test must be conducted by subjecting the brake assembly to 100,000 cycles of an application of the average of the peak brake pressures needed in the Design Landing Stop Test (paragraph 3.3.2) and release to a pressure not exceeding the brake rated return pressure,  $BRP_{RET}$ . The pistons must be adjusted so that 25,000 cycles are performed at each of the four positions where the pistons would be at rest when adjusted to nominally 25, 50, 75 and 100 percent of the wear limit, BRWL. The brake must then be subjected to 5000 cycles of application of pressure to  $BRP_{MAX}$  and release to  $BRP_{RET}$  at the 100 percent wear limit.

Hydraulic brakes must meet the leakage requirements of paragraph 3.4.5 at the completion of the test.

### 3.4.3 Piston Retention.

The hydraulic pistons must be positively retained without leakage at 1.5 times  $BRP_{MAX}$  for ten seconds with the heat sink removed.

### 3.4.4 Extreme Temperature Soak Test

The brake actuation system must comply with the dynamic leakage limits of paragraph 3.4.5.2 for the following tests.

Subject the brake to a 24-hour hot soak at the maximum piston housing fluid temperature experienced during the Design Landing Stop Test (paragraph 3.3.2), conducted without forced air cooling. While at the hot soak temperature, the brake must be subjected to the application of the average of the peak brake pressures required during the 100 design landing stops and release to a pressure not exceeding  $BRP_{RET}$  for 1000 cycles, followed by 25 cycles of  $BRP_{MAX}$  and release to a pressure not exceeding  $BRP_{RET}$ .

The brake must then be cooled from the hot soak temperature to a cold soak temperature of  $-40^{\circ}\text{F}$  ( $-40^{\circ}\text{C}$ ) and maintained at this temperature for 24 hours. While at the cold soak temperature, the brake must be subjected to the application of the average of the peak brake pressures required during the  $KE_{DL}$  stops and release to a pressure not exceeding  $BRP_{RET}$ , for 25 cycles, followed by 5 cycles of  $BRP_{MAX}$  and release to a pressure not exceeding  $BRP_{RET}$ .

### 3.4.5 Leakage Tests (Hydraulic Brakes).

#### 3.4.5.1 Static Leakage Test.

The brake must be subjected to a pressure equal to 1.5 times  $BRP_{MAX}$  for 5 minutes. The brake pressure must then be adjusted to an operating pressure of 5 psig (35 kPa) for 5 minutes. There must be no measurable leakage (less than one drop) during this test.

#### 3.4.5.2 Dynamic Leakage Test.

The brake must be subjected to 25 applications of  $BRP_{MAX}$ , each followed by the release to a pressure not exceeding  $BRP_{RET}$ . Leakage at static seals must not exceed a trace. Leakage at moving seals must not exceed one drop of fluid per each 3 inches (76mm) of peripheral seal length.

## CHAPTER 4

### DATA REQUIREMENTS.

4.1 The manufacturer must provide the following data with any application for approval of equipment.

4.1.1 The following wheel and brake assembly ratings:

a. Wheel Ratings.

Wheel Rated Static Load, S  
 Wheel Rated Inflation Pressure, WRP  
 Wheel Rated Tire Loaded Radius, R  
 Wheel Rated Maximum Limit Load, L  
 Wheel Rated Tire Size,  $TS_{WR}$

b. Wheel/Brake and Brake Ratings.

Wheel/Brake Rated Design Landing Energy,  $KE_{DL}$ , and associated brakes-on-speed,  $V_{DL}$   
 Wheel/Brake Rated Accelerate-Stop Energy,  $KE_{RT}$ , and associated brakes-on-speed,  $V_{RT}$   
 Wheel/Brake Rated Most Severe Landing Stop Energy,  $KE_{SS}$ , and associated brakes on-speed,  $V_{SS}$  ( if applicable).  
 Brake Rated Maximum Operating Pressure,  $BROP_{MAX}$ .  
 Brake Rated Maximum Pressure,  $BRP_{MAX}$ .  
 Brake Rated Retraction Pressure,  $BRP_{RET}$   
 Wheel/Brake Rated Structural Torque,  $ST_R$ .  
 Rated Design Landing Deceleration,  $D_{DL}$ .  
 Rated Accelerate-Stop Deceleration,  $D_{RT}$ .  
 Rated Most Severe Landing Stop Deceleration,  $D_{SS}$  ( if applicable).  
 Brake Rated Tire Size,  $TS_{BR}$ .  
 Brake Rated Wear Limit, BRWL

4.1.2 The weight of the wheel or brake, as applicable.

4.1.3 Type of hydraulic fluid used, as applicable.

4.1.4 One copy of the test report showing compliance with the test requirements.

NOTE: When test results are being recorded for incorporation in the compliance test report, it is not sufficient to note merely that the specified performance was achieved. The actual numerical values obtained for each of the parameters tested must be recorded, except where tests are pass/fail in character.

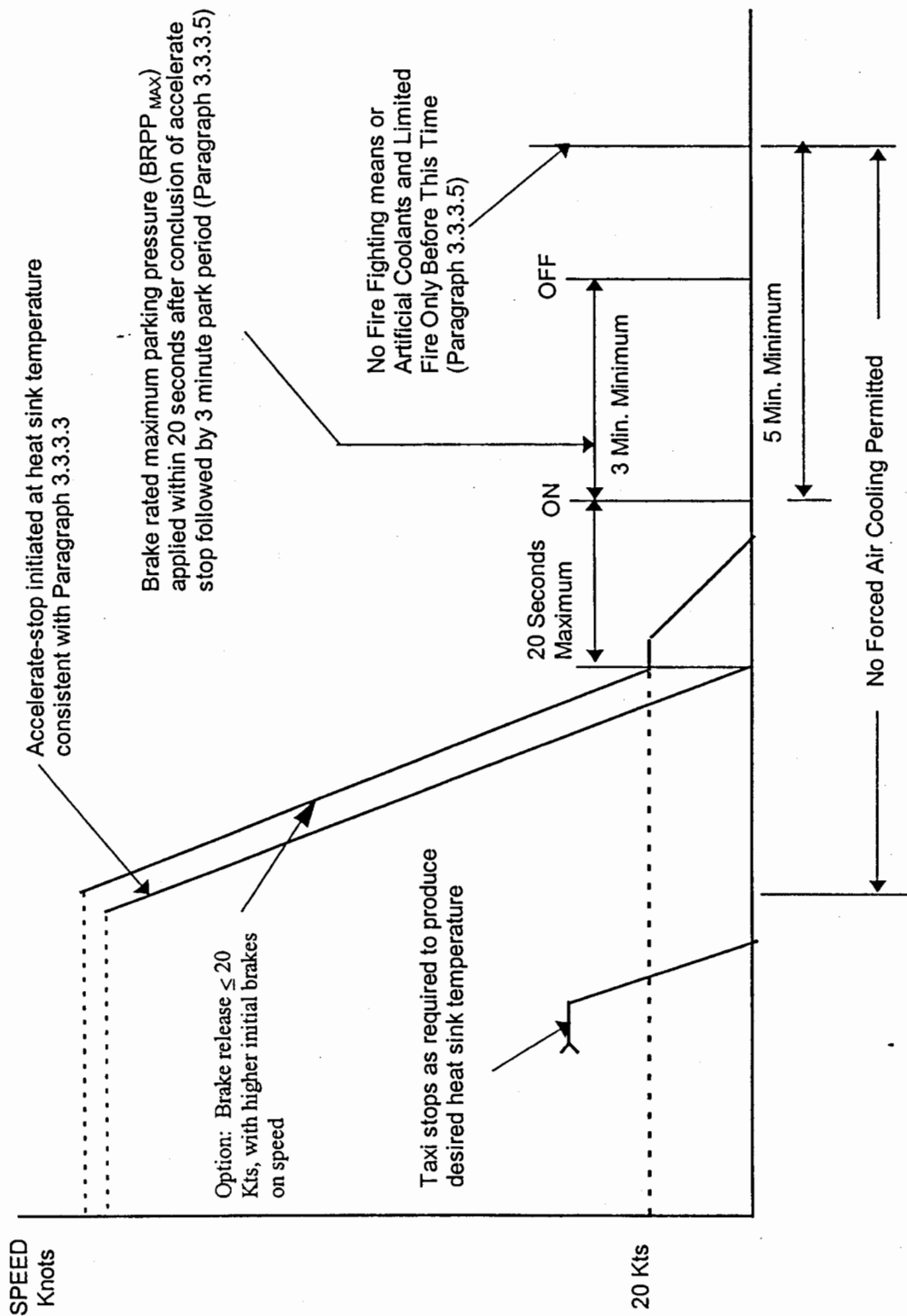


Figure 3-1. Taxi, Accelerate-Stop, Park Test Sequence

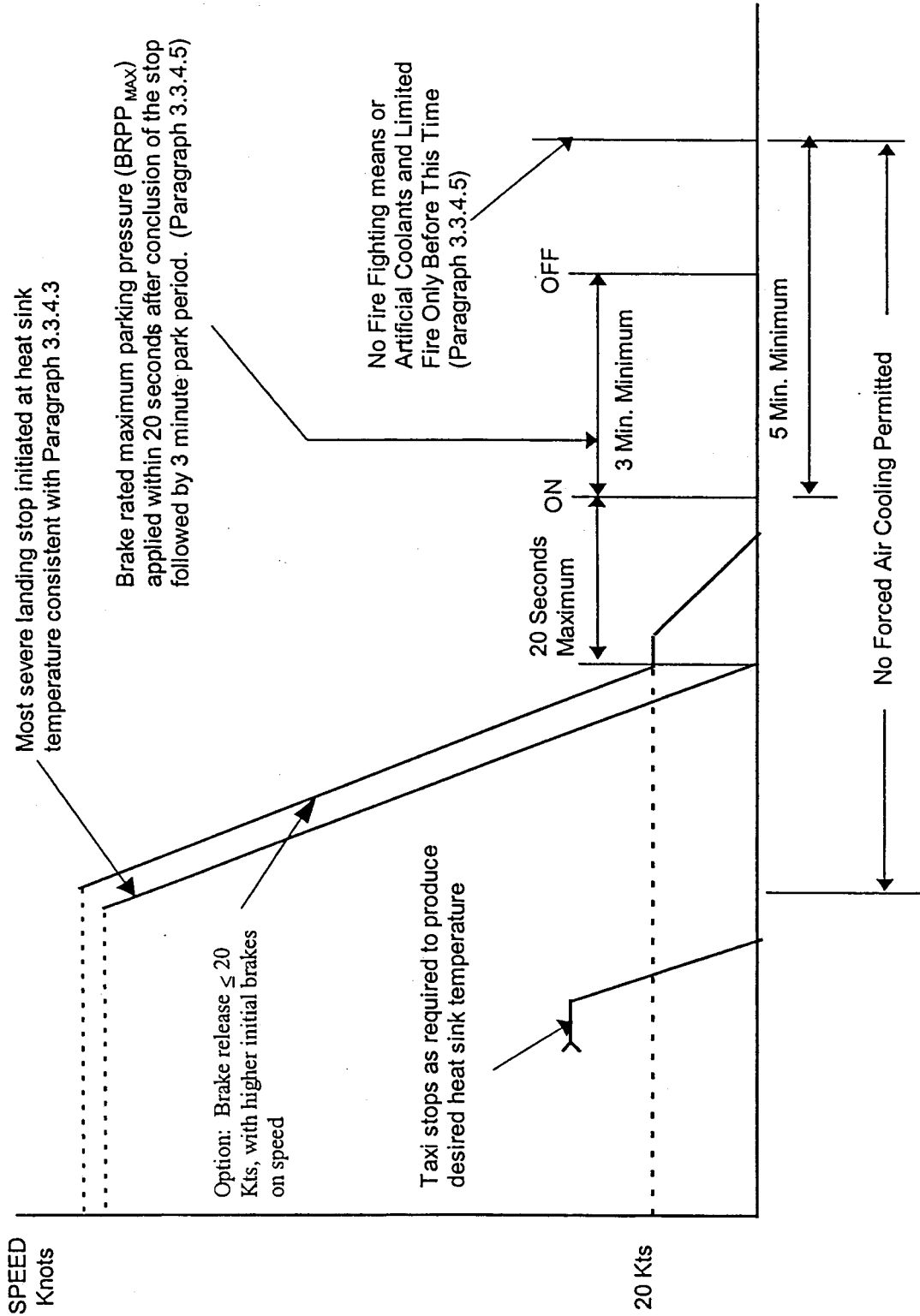


Figure 3-2. Most Severe Landing-Stop, Park Test Sequence

FAA Action – Not Available